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A new species of *Austrocypraea* (Gastropoda: Cypraeidae) from the Late Pliocene of the Eucla Basin, southern Australia

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Abstract – A new species of fossil cowrie, *Austrocypraea amae* sp. nov., hitherto misidentified, is described from the Roe Calcarenite of the Eucla Basin. The new species is intermediate in morphology between the Miocene *A. contusa* (McCoy, 1877) and the extant *A. reevei* (Sowerby, 1832). It provides the first confirmation from the Pliocene for this endemic southern Australian genus.

INTRODUCTION

In her pioneering contribution on the malacofauna of the Roe Calcarenite of the Eucla Basin, Ludbrook (1978), from limited material, recorded the present species as *Cypraea (Austrocypraea) reevei* Sowerby, whilst noting some differences from the typical form of that species, the sole living representative of the genus.

Re-examination of the Ludbrook material, together with a wider range of additional specimens, has led the present authors to conclude that the Roe *Austrocypraea* differs consistently from all others of the genus sufficiently to justify its recognition as a new species.

Austrocypraea amae sp. nov. presents an intermediate morphology and age between the Miocene *A. contusa* (McCoy) and the extant *A. reevei* (Sowerby).

Abbreviations of specimen repositories: HMB – Humboldt Museum, Berlin, Federal Republic of Germany; NMV – Museum of Victoria, Melbourne, Australia; WAM – Western Australian Museum, Perth, Australia.

SYSTEMATICS

Family Cypraeidae Rafinesque, 1815 (as Cypridia)

Genus *Austrocypraea* Cossmann, 1903

Type Species

Cypraea (Luponia) contusa McCoy, 1877.

Austrocypraea amae sp. nov.

Figures 1, A-L, 2, A-J

1978 *Cypraea (Austrocypraea) reevei* Sowerby; Ludbrook: 130, plate 13, figures 17, 18.

Material Examined

Holotype

WAM 69.495, from Roe Plains, Madura district, Western Australia; spoil from foundation holes, Hampton Microwave Repeater Tower (lat. 31°57'57"S, long. 127°34'45"E), collected T.A. Darragh, M. Archer and G.W. Kendrick, 5 March 1969. Roe Calcarenite, Late Pliocene.

Paratypes

HMB 102445-50, from Roe Plains. Total of six specimens. NMV P303505/6, excavation 1.5 km N of type locality (NMV locality PL 3167). Two specimens. WAM 80.67 a, b, c, g, excavation 1.5 km N of type locality; basal 0.4 m carbonate sand. 80.145a-j, excavation 0.5 km N of type locality, spoil heaps on floor of pit. Fourteen specimens.

Other material

WAM 62.32a-b, 65.685, 69.496, 69.517, 69.550, 69.575, 70.18, 70.1819, 71.321, 71.331, 80.67d-f, h, 80.108, 82.2444. Total of 18 specimens. Collection of D. Fehse, unnumbered, total of 35 specimens.

All of the study material was collected from the Roe Calcarenite of the Eucla Basin, in Western Australia.

Diagnosis

Medium-sized, robust, somewhat variable *Austrocypraea*, ovate-subpyriform, occasionally subcylindrical, with spaced, weak to strong apertural dentition; columellar teeth 14-22 (mean 16.8), labial teeth 17-32 (mean 22.8), latter always exceeding former; maximum globosity at posterior third; apex just visible or depressed and overlain by callus.

Differs from *A. reevei* in fewer, stronger, more spaced apertural teeth, more concealed apex, globosity greatest at posterior third and smaller

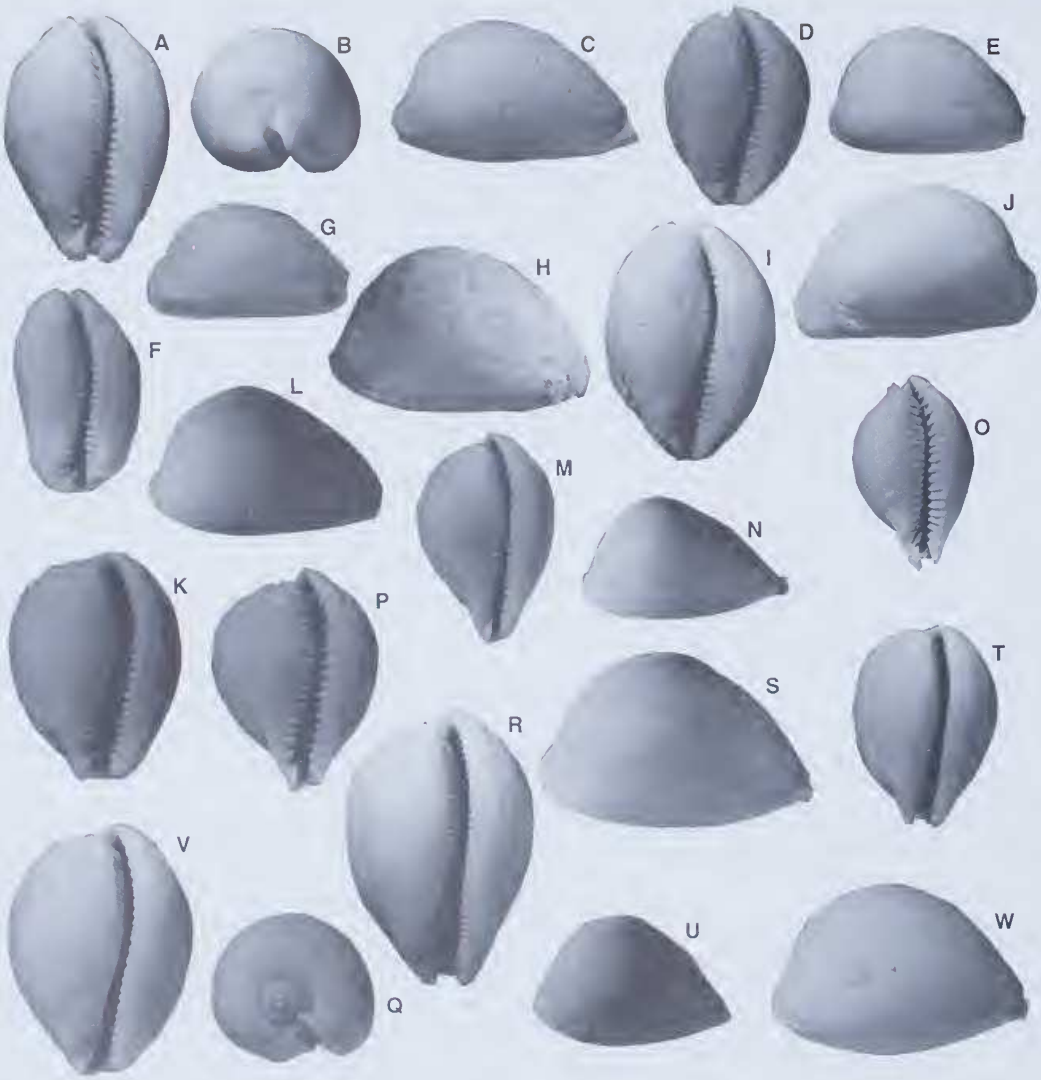

Figure 1 A–L, *Austrocypraea amae* sp. nov. from Roe Calcarenite, Eucla Basin, Western Australia: A–C WAM 69.495, holotype, x 1; A apertural, B apical, C left lateral (probable mature female specimen). D–E WAM 80.67a, paratype, x 1; D apertural, E left lateral. F–G WAM 80.67b, paratype, x 1; F apertural, G left lateral. H WAM 71.331a, paratype, x 1½, left lateral. I–J WAM 80.67c, paratype, x 1; I apertural, J right lateral (probable mature female specimen). K–L WAM 80.145j, paratype, x 1½, K apertural, L left lateral. M – Q *Austrocypraea contusa* (McCoy, 1877): All figured specimens are topotypes from Mornington, Victoria, Fyansford Fm, Balcombian. M–N WAM 71 221a, x 1; M apertural, N left lateral. O WAM 71.221b, x 1; apertural. P–Q WAM 71.221d, x 1.5; P apertural, Q apical. R–W *Austrocypraea reevei* (Sowerby, 1832): R–S WAM 66-62, Frenchman Bay via Albany, W.A., alive low water, Dec. 1961, probable mature female. R apertural, S left lateral, x 1. T–U WAM 135-78, Cervantes, W.A., 11 m, Feb. 1965, T. apertural, U left lateral, x 1. V–W WAM S12342, ca, 100 km west of Dongara, W.A., MV Sprightly stn 29M, lat 29°08.5'S–29°09'S, long. 113°55.5'E–113°56'E, dredged Feb. 1976, V apertural, W left lateral, x 1.5. All whitened except H.

size; from *A. contusa*, differs in more discrepant dentition, shorter anterior extremity, reduced globosity and malleation, more concealed apex and greater size.

Description

Medium size for genus, robust, somewhat variable, typically ovate-subpyriform, occasionally subcylindrical; length exceeds width and height;

Table 1 Dimensions of *Austrocypraea amae* sp. nov.

Specimens (catalogue numbers)	Length	Width	Height	Columellar teeth	Labial teeth
WAM 69.495 holotype	38.9	26.7	22.3	21	32
WAM 71.331a paratype	28.1	21.1	17.3	14	23
WAM 80.67a paratype	30.9	23.4	19.7	17	30
WAM 80.67b paratype	31.7	20.3	18.1	17	23
WAM 80.67c paratype	38.3	28.2	23.3	22	27
WAM 80.67g paratype	30.1	20.1	17.1	15	17
WAM 80.145a paratype	29.2	21.7	18.1	18	25
WAM 80.145b paratype	28.6	19.9	16.8	16	25
WAM 80.145c paratype	27.9	20.7	17.3	18	23
WAM 80.145d paratype	27.7	18.9	16.0	14	18
WAM 80.145e paratype	24.5	17.9	15.1	15	21
WAM 80.145f paratype	26.4	18.3	15.5	16	20
WAM 80.145g paratype	24.6	17.1	14.6	15	20
WAM 80.145h paratype	22.5	16.9	13.9	15	22
WAM 80.145i paratype	20.7	14.7	12.4	15	17
WAM 80.145j paratype	24.8	18.2	15.6	16	23
HMB 102445 paratype	27.3	18.8	16.0	17	23
HMB 102446 paratype	29.5	20.9	17.0	17	23
HMB 102447 paratype	26.0	18.6	14.6	15	18
HMB 102448 paratype	25.9	18.5	15.5	16	20
HMB 102449 paratype	30.8	22.3	19.1	17	24
HMB 102450 paratype	26.5	19.1	15.7	18	24

narrowed and slightly extended anteriorly, flattened posteriorly; moderately globose, dorsum gibbous, greatest at posterior third; base roundly convex; protoconch paucispiral, domed (WAM 69.576); apex depressed or slightly elevated, frequently overlain by callus, latter weakly to moderately developed; aperture sinuate, widening anteriorly, without columellar peristome; anterior and posterior canals deep, bordered by strong projecting callus, latter curved; teeth weak to moderately strong, spaced, slightly irregular in strength and spacing, increasing occasionally by intercalation, absent from base; columellar teeth number 14-22 (mean 16.8, 73 specimens), extending well into aperture and extending very slightly across anterior end of columella; labial teeth 17-32 (mean 22.8, 73 specimens), always exceeding columellar teeth and extending slightly onto lip; fossula broad, impressed, with about six or seven (range 4-9) ribs, continuous with the columellar teeth and bordered anteriorly by strong, curved, internal rib defining anterior canal.

Sculpture usually faint, more apparent posteriorly, occasionally stronger and present generally (e.g., figure 1H) except on base, of weak transverse growth ridges and fine, spaced spiral threads, forming tessellate rows of very shallow pitting (malleation); surface gloss occasionally retained; under UV light and occasionally in normal light, faint darkening of anterior and posterior extremities visible.

Dimensions

Length refers to the greatest anterior/posterior measurement; width to the greatest lateral (left-right) measurement with the shell at rest on the base; height refers to the maximum globosity from the base through to the dorsal extremity. Counts of columellar teeth exclude the strong internal rib bordering the anterior canal. Denticles at the posterior end of the labial teeth have been counted as full teeth.

Etymology

The name of the species honours Mrs Elizabeth Ama Fehse.

REMARKS ON SHELL MORPHOLOGY

As *Cypraea (Austrocypraea) reevei* Sowerby, the present species was recorded from the Roe Calcarenite and described fully by Ludbrook (1978). The redescription herein, based on the previous and additional material, adds little. Ludbrook remarked on differences between specimen WAM 69.495 (holotype, figure 1, A-C) and "more typical *C. (A.) reevei*" (*ibid.*, p. 130). She also noted the relationship of Sowerby's species to "*C. (A.) contusa* McCoy" from "Balcombe Bay" (= Mornington, Fyansford Formation, Balcombian), which is recorded in southeastern Australia from the Janjukian (Late Oligocene) to Bairnsdalian (late Middle Miocene) (Darragh, 1985; Li *et al.*, 1999).

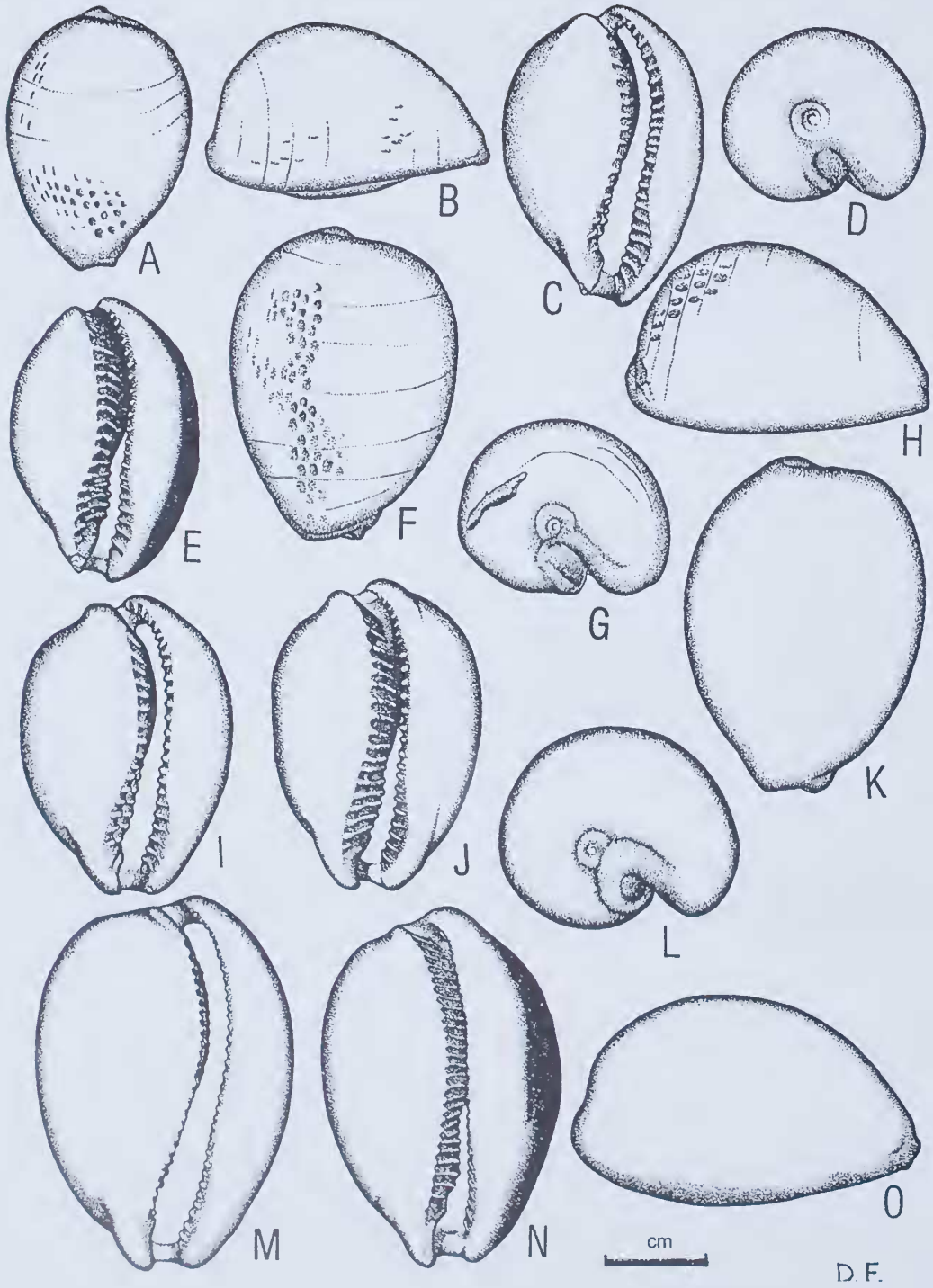

Figure 2 A–J, *Austrocypraea amae* sp. nov., Roe Plains, Western Australia (Roe Calcarenite, Late Pliocene): A–E, HMB 102445 (paratype). F–J, HMB 102446 (paratype). K–O *Austrocypraea reevei* (Sowerby, 1832). Recent, Western Australia. DFB Collection, no. 2212A15141514 (1188). Two apertural view of each specimen positioned to show labial and columellar dentition. All x 1.8.

The new species from the Roe Calcarenite presents a distinctive combination of shell characters that distinguish it from both *A. contusa* and *A. reevei*, consistent with a somewhat intermediate, probably transitional morphology connecting the two.

Notable intra-specific variation in shell characters is a feature of the temperate-water Cypraeidae of southern Australia, including *Austrocypraea reevei*, as has been remarked on by Wilson (1993: 172-198). In these groups, variable shell morphologies (and colours) appear to be a consequence of prolonged, direct larval development, associated with localised, favourable habitats and maintained by potentially high levels of planktonic predation. This contrasts with the generally prevailing planktotrophic larval development of the tropical cypraeids.

Wilson (1985: 276) reported that female *Austrocypraea reevei* brood the egg mass, which is attached to the substratum, for ca 55 days and appear incidentally, to possess a larger, more tumid shell than that of the males (Wilson, 1993). Deep water specimens of *A. reevei* from the middle to outer continental shelf (this paper, figure 2 E, F) have thinner, more globose and unpigmented shells compared with those from more energised, inshore situations. Shell variation, which probably includes a sexual dimorphism, characterises both *A. contusa* (McCoy) and the present species, as well as the extant *A. reevei*, suggesting that this kind of reproductive biology has been operative since the Oligo-Miocene.

To summarise Table 2, it will be noted that, for maximum length, the present species is intermediate (on the data to hand) between *A. contusa* and *A. reevei*; in shape and sculpture, it tends to more resemble *reevei* except that in the position of the dorsal dome and also in the number, size and spacing of the apertural teeth it lies closer to *contusa* (Figure 3). However, in *contusa* the labial teeth usually exceed in number the columellar teeth, within a range of −1 (WAM G1508) to +6 (ten specimens); with *A. amae* (70 specimens) and *A. reevei* (30 specimens), the labial teeth for both species always exceed the columellar teeth by a margin of +1 to +13. The apex is less prominent in *A. amae* than in either of the other two.

A pink suffusion around the anterior and posterior (including apical) extremities is a feature of *A. reevei* and is occasionally visible in ordinary light on specimens of *A. contusa* (e.g., WAM G1509). A comparable faint, dark tinting at the extremities of specimens of *A. amae* may be seen under both ordinary (e.g., holotype) and UV light, evidently a persistence of the same character.

From this *mélange* of characters, we conclude that the three taxa (*contusa, amae* and *reevei*) represent a single evolutionary lineage, located during the Oligo-Miocene in southeastern Australia and subsequently (Pliocene-Recent) confined to southwestern Australia.

DISCUSSION

Kay (1996), apparently following Schilder (1935) and Schilder and Schilder (1971), incorrectly included *Austrocypraea* among the extinct genera of the Cypraeidae, assigning to it a time-range of Early Eocene to Late Miocene. The older part of this range appears to be derived from the Schilders' (*ibid.*) inclusion of *Cypraea ovulatella* Tate in *Austrocypraea*. *C. ovulatella* is a triviid and more credibly located in the genus *Willungia* Powell; it is

Table 2 Comparison of shell characters for *Austrocypraea contusa* (McCoy, 1877), *A. amae* sp. nov. and *A. reevei* (Sowerby, 1832).

Species Characters	*A. contusa* (Figure 1, M-Q)	*A. amae* sp. nov. (Figure 1, A-L)	*A. reevei* (Figure 1, R-W)
1. Maximum length	33.0	38.9	43.7
2. Shape	ovate-pyriform, anteriorly extended; dorsal dome at ca posterior third	ovate-subpyriform, occ. subcylindrical; dorsal dome at ca posterior third	ovate-subpyriform, occ. subcylindrical; dorsal dome near middle
3. Sculpture	intensely malleate, base usually smooth	moderately to weakly malleate, mainly posteriorly; base smooth	
4. Apex	visible, small	very small, often sunken or overlain by callus	visible, small, occ. slightly elevated
5. Columellar teeth	strong, spaced; 13-23 (mean 17.5)	usually strong, spaced; 14-22 (mean 16.8)	fine, close 21-30 (mean 25.3)
6. Labial teeth	strong, spaced, usually exceeding columellar teeth; 18-26 (mean 20.0)	usually strong, spaced, always exceeding columellar teeth; 17-32 (mean 22.8)	fine, close, always exceeding columellar teeth; 25-43 (mean 32.3)

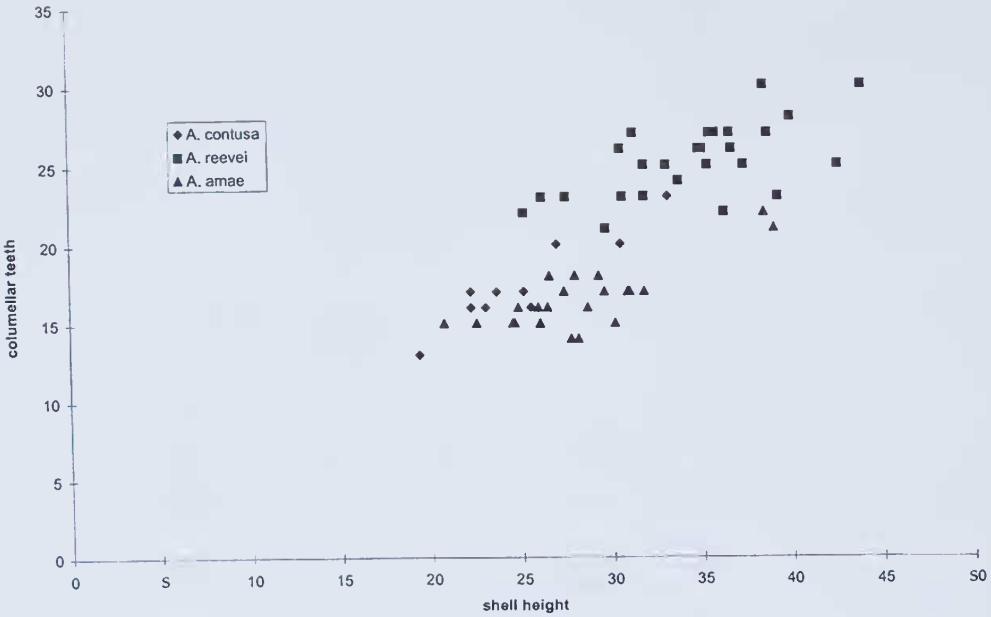

Figure 3 Morphometric comparison of columellar teeth to shell height for species of *Austrocypraea*.

common in the Late Eocene of southern Australia and may persist into the Early Oligocene (Darragh, 1985). The time range of *Austrocypraea* on present knowledge is Janjukian (Late Oligocene) to Recent (*ibid.*) The present species provides the first authenticated record of the genus from the Pliocene, intermediate in age and morphology between the Miocene *A. contusa* and the extant *A. reevei*. Eight nominal species of *Austrocypraea* are on record from the Oligo-Miocene of southeastern Australia (Darragh, 1970 and references) but most of these, the exception being *A. contusa*, evidently represent extinct lineages.

The Roe Calcarenite (Lowry, 1970) is a thin (up to 7.5 m thick, usually much less), richly fossiliferous, bioclastic calcarenite, forming most of the surface of the Roe Plains along the onshore southern Eucla Basin. It overlies unconformably an erosion surface of Wilson Bluff (Eocene) and Abrakurrie (Oligo-Miocene) Limestones (Li *et al.*, 1996). The Roe substratum was of fine carbonate sand with extensive seagrass development in shallow (to ca 10 m), well-circulated water along an open coast. Evidence for a Late Pliocene age is presented by Kendrick *et al.* (1991).

A. amae is common in the Roe Calcarenite and probably, like its modern equivalent *A. reevei*, was associated with hard substrates. These are not readily identifiable within the formation but were probably present along the eroding face of the Hampton Scarp, which formed the shoreline for much of the Late Pliocene Roe transgression.

No confirmed fossil record now stands for *A. reevei*. Despite extensive searching, no specimen has been recognised in the rich and well preserved assemblages from the Ascot Formation (Late Pliocene – Early Pleistocene) and Tamala Limestone (Middle – Late Pleistocene) of the Perth Basin (Kendrick *et al.*, 1991). The Eucla Basin and Roe Calcarenite lie within the modern geographical range of *A. reevei*, which in WAM records extends from the Yorke Peninsula of central South Australia (longitude 137°E) to Kalbarri, Western Australia (latitude 28°S); anecdotal evidence, unconfirmed, would extend that range northward to about latitude 26°S.

This paper follows others on Mollusca from the Roe Calcarenite by Vokes (1985) on *Dermomurex*, Darragh (1986) on Trigoniidae, Darragh (1989, 1992) on Volutidae and Darragh (1991) on *Tylospira*; on Echinodermata by Foster and Philip (1980) and McNamara (1996); on Brachiopoda by Craig (1999).

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